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Report on Lake Sakakawea; Dunn, McKenzie, McLean, Mercer, Mountrail, and Williams Counties, North Dakota

National Eutrophication Survey, Corvallis, Oreg

Prepared for

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NATIONAL EUTROPHICATION SURVEY

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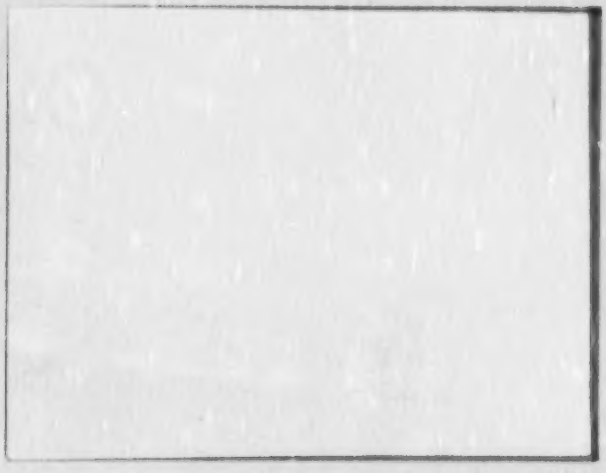

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

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REPORT

ON

LAKE SAKAKAWEA

DUNN, MCKENZIE, MCLEAN, MERCER,

MOUNTRAIL, AND WILLIAMS COUNTIES

NORTH DAKOTA

EPA REGION VIII

WORKING PAPER NO. 575

WITH THE COOPERATION OF THE

NORTH DAKOTA STATE DEPARTMENT OF HEALTH

AND THE

NORTH DAKOTA NATIONAL GUARD

SEPTEMBER, 1976

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

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F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the North Dakota State Department of Health for professional involvement, to the North Dakota National Guard for conducting the tributary sampling phase of the Survey, and to those North Dakota wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

Norman L. Peterson, Director, and the staff of the Division of Water Supply and Pollution Control of the Department of Health, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

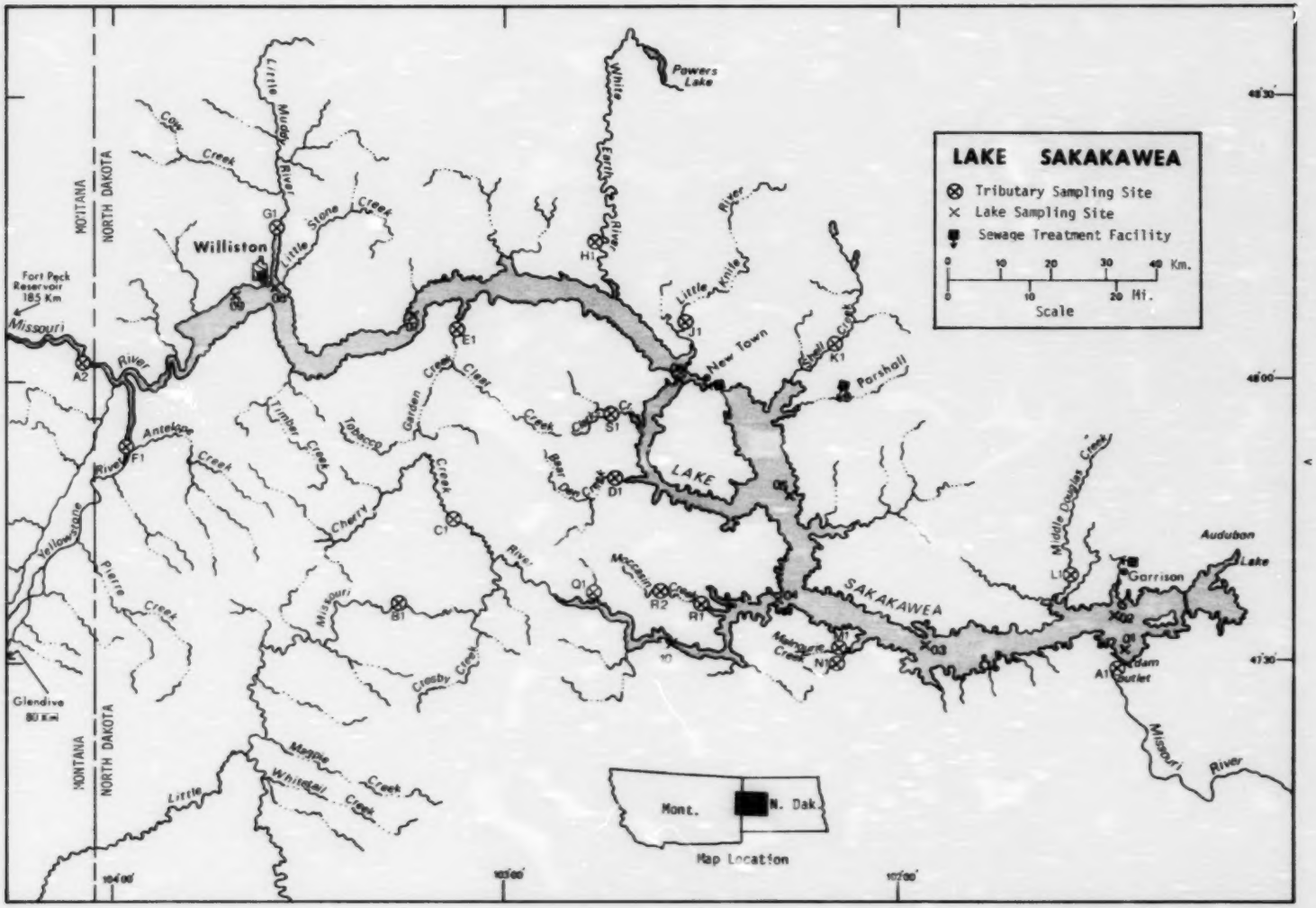
Major General LaClair A. Melhouse, the Adjutant General of North Dakota, and Project Officer Colonel Irvin M. Sande, who directed the volunteer efforts of the North Dakota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES AND RESERVOIRS

STATE OF NORTH DAKOTA

NAME	COUNTY
Ashtabula	Barnes, Griggs
Audubon	McLean
Brush	McLean
Darling	Renville, Ward
Devils	Benson, Ramsey
Jamestown	Stutsman
LaMoure	LaMoure
Matejcek	Walsh
Metigoshe	Bottineau
Pelican	Bottineau
Sakakawea	Dunn, McKenzie, McLean, Mercer, Mountrail, Williams
Spiritwood	Stutsman
Sweet Briar	Morton
Whitman	Nelson, Walsh


LAKE SAKAKAWEA
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
0 10 20 30 40 Km.
0 10 20 Mi.
Scale
Williston
Fort Peck Reservoir 185 Km
Missouri River
MONTANA
NORTH DAKOTA
Powers Lake
White Earth River
Little Muddy River
Cow Creek
Stone Creek
Little Knife River
New Town
Parshall
Shell Creek
Garden Creek
Tobacco Creek
Timber Creek
Antelope Creek
Cherry Creek
Bear Den Creek
Yellowstone River
Missouri River
McLeans Creek
Middle Douglas Creek
Garrison
Audubon Lake
SAKAKAWEA
LAKE
Dam Outlet
Glendive 80 Km
Crosby Creek
Maple Creek
Whitetail Creek
Little Missouri River
Mont.
N. Dak.
Map Location
48°30'
48°00'
47°30'
104°00'
103°00'
102°00'

LAKE SAKAKAWEA

STORET NO. 3812

I. CONCLUSIONS

A. Trophic Condition:

Lake Sakakawea ranked third in overall trophic quality when the 14 North Dakota lakes sampled in 1974 were compared using a combination of six parameters*. However, the lake data show that this long water body (ca. 286 km; see map, page v) is oligotrophic from the dam to the vicinity of the Little Missouri embayment; mesotrophic in the vicinity of sampling station 5 and, on the basis of limited nutrient data, in the Little Missouri embayment (station 10); eutrophic at stations 6 and 7; and hypereutrophic at station 8. Essentially, station 9 was a river station; Survey limnologists noted a defined channel, perceptable current, and sediment turbidity.

At oligotrophic stations 1, 2, 3, and 4, spring and fall mean total phosphorus ranged from 10 to 21 µg/l; spring and fall mean orthophosphorus ranged from 3 to 9 µg/l; mean chlorophyll *a* ranged from 1.3 to 2.3 µg/l; and mean Secchi disc transparency ranged from 2.5 to 4.3 meters. No significant depression of dissolved oxygen occurred at any of the four stations at depths as great as 53.6 meters.

At mesotrophic stations 5 and 10, spring and fall mean total phosphorus ranged from 16 to 32 µg/l; spring and fall mean orthophosphorus ranged from 4 to 18 µg/l; mean chlorophyll *a* ranged

* See Appendix A.

from 2.0 to 3.0 µg/l; and mean Secchi disc transparency ranged from 1.5 to 4.0 meters. Depression of dissolved oxygen with depth occurred at station 5 in September (to 4.8 mg/l at 33.5 meters); the maximum depth sampled at station 10 was 2.4 meters.

At eutrophic stations 6 and 7, spring and fall mean total phosphorus ranged from 21 to 53 µg/l; spring and fall mean orthophosphorus ranged from 6 to 19 µg/l; mean chlorophyll a ranged from 7.2 to 7.6 µg/l; and mean Secchi disc transparency ranged from 0.8 to 1.4 meters. Some depression of dissolved oxygen with depth occurred at both stations in July (the maximum depth sampled was 22.9 meters).

At hypereutrophic station 8, the means of the spring and fall total phosphorus were 158 and 61 µg/l; the means of the spring and fall orthophosphorus were 15 and 12 µg/l; the mean chlorophyll a was 30.3 µg/l; and the mean Secchi disc transparency was 0.3 meters.

B. Rate-Limiting Nutrient:

The algal assay results indicate Lake Sakakawea was phosphorus limited at the time the three samples were collected (04/30/74). However, the lake data indicate that station 8 was nitrogen limited at that time.

The July lake data indicate phosphorus limitation at stations 1, 2, 3, and 4 but nitrogen limitation at station 5. The September data indicate phosphorus limitation at stations

1, 2, 3, 4, and 10 and nitrogen limitation at stations 5 through 9.

C. Nutrient Controllability:

1. Point sources--The phosphorus contribution of point sources considered in this report accounted for less than 1% of the total load reaching the lake during the sampling year. However, there are many municipal and industrial point sources beyond the 40-kilometer limit of the Survey*--including the Montana communities of Glendive, Miles City, and Billings and a number of industries on the Yellowstone River and Glasgow, Havre, and Great Falls and industries in the Missouri River drainage--so the actual point-source phosphorus load is not known.

The present phosphorus loading of 4.49 $g/m^2/yr$ is <u>over six times</u> that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 17). It is calculated that an 85% reduction (ca. 5,700,000 kg) of the entire phosphorus load measured during the sampling year would be required to just equal a eutrophic loading, and it is questionable whether even complete removal of point-source phosphorus would reduce the load that much. However, unless the present loading can be reduced, an increasingly greater proportion of Lake Sakakawea will become eutrophic, and every effort should be made to reduce all phosphorus inputs to the greatest practicable degree to at least slow the rate of eutro-

* See Working Paper No. 175, "...Survey Methods, 1973-1976".

phication of the lake.

2. Non-point sources--It is calculated that the gaged tributaries contributed nearly 95% of the total phosphorus load during the sampling year. The Yellowstone River load amounted to 70.0% of the total, the Missouri River load accounted for 25.4%, and the remaining five gaged tributaries collectively contributed 1.4% of the load.

Except for the Yellowstone River and Moccasin Creek, the phosphorus export rates of the gaged tributaries were quite low (see page 16). The high rate of the Yellowstone River probably was the result of the unsampled point sources noted above. However, the cause of the relatively high Moccasin Creek rate is not evident in Survey data and available information.

While nutrient concentrations in the smaller gaged streams were quite high (Appendix E), the low, sometimes intermittent flows of these streams (Appendix C) resulted in low nutrient loads. The nutrient concentrations in sampled but ungaged tributaries also were quite high (see page 16), but it is likely that these streams have low flows (and loads) as well.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 1490.21 kilometers^2.
2. Mean depth: 18.9 meters.
3. Maximum depth: 54.9 meters.
4. Volume: 28,164.969 x 10^6 m^3.
5. Mean hydraulic retention time: 1.6 years (based on outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Missouri River	238,383.5	276.80
Little Missouri River	21,522.9	17.24
Cherry Creek	761.5	0.41
Yellowstone River	180,730.1	341.19
Little Muddy River	2,007.2	0.91
Moccasin Creek R-2	57.0	0.03
Clarks Creek	106.2	0.04
Minor tributaries & immediate drainage -	24,767.2	16.31
Totals	468,335.6	652.93

2. Outlet -

Missouri River	469,825.8**	566.84

C. Precipitation***:

1. Year of sampling: 42.7 centimeters.
2. Mean annual: 40.6 centimeters.

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† Table of metric conversions--Appendix B.
†† Henegar, 1975.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Lake Sakakawea was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Samples for physical and chemical parameters were collected from ten stations on the lake (nine in April) and from a number of depths at each station (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the April visit, three 18.9-liter depth-integrated samples were composited for algal assays (stations 1, 2, and 3 were combined; 4, 5, and 6 were combined; and 7, 8, and 9 were combined). Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 53.6 meters at station 1, 19.8 meters at station 2, 38.4 meters at station 3, 24.7 meters at station 4, 33.5 meters at station 5, 22.9 meters at station 6, 9.4 meters at station 7, 2.7 meters at station 8, near-surface only at station 9, and 2.4 meters at station 10.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR LAKE SAKAKAWEA
STORET CODE 3812

PARAMETER	1ST SAMPLING (4/30/74) 9 SITES			2ND SAMPLING (7/18/74) 10 SITES			3RD SAMPLING (9/17/74) 10 SITES		
	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN
TEMP (C)	2.3 - 12.1	5.3	3.4	7.4 - 29.2	19.9	21.6	10.3 - 17.3	14.8	15.1
DISS OXY (MG/L)	8.8 - 12.6	11.3	11.6	4.2 - 9.8	7.8	8.8	4.8 - 9.8	8.6	8.8
CNDCTVY (MCROMO)	393. - 715.	466.	430.	433. - 1435.	650.	634.	425. - 1012.	561.	557.
PH (STAND UNITS)	7.7 - 8.3	8.1	8.1	7.8 - 8.9	8.2	8.4	7.3 - 8.2	8.0	8.0
TOT ALK (MG/L)	145. - 324.	173.	165.	157. - 181.	171.	172.	136. - 250.	165.	164.
TOT P (MG/L)	0.007 - 0.705	0.048	0.017	0.009 - 0.117	0.028	0.013	0.006 - 0.072	0.021	0.016
ORTHO P (MG/L)	0.002 - 0.020	0.007	0.006	0.004 - 0.088	0.019	0.008	0.002 - 0.029	0.011	0.010
NO2+NO3 (MG/L)	0.080 - 0.470	0.144	0.130	0.070 - 0.220	0.128	0.120	0.020 - 0.200	0.094	0.090
AMMONIA (MG/L)	0.020 - 0.090	0.042	0.040	0.020 - 0.120	0.051	0.040	0.020 - 0.080	0.033	0.030
KJEL N (MG/L)	0.200 - 1.100	0.281	0.200	0.200 - 0.900	0.270	0.200	0.200 - 0.700	0.237	0.200
INORG N (MG/L)	0.120 - 0.560	0.186	0.165	0.090 - 0.340	0.178	0.170	0.050 - 0.280	0.127	0.120
TOTAL N (MG/L)	0.280 - 1.470	0.424	0.330	0.270 - 0.990	0.397	0.340	0.220 - 0.780	0.331	0.300
CHLRPYL A (UG/L)	0.8 - 24.8	6.1	3.1	1.2 - 35.5	7.1	1.7	1.3 - 30.6	7.4	2.2
SECCHI (METERS)	0.2 - 5.9	2.6	2.4	0.2 - 5.5	2.5	2.7	0.3 - 3.4	1.8	1.8

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/30/74	1. Stephanodiscus sp.	857
	2. Flagellates	785
	3. Pennate diatoms	321
	4. Asterionella sp.	250
	5. Cryptomonas sp.	178
	Other genera	608
	Total	2,999
07/18/74	1. Melosira sp.	376
	2. Synedra sp.	376
	3. Centric diatoms	301
	4. Oscillatoria sp.	75
	5. Flagellates	75
	Other genera	226
	Total	1,429
09/17/74	1. Flagellates	786
	2. Oscillatoria sp.	337
	3. Stephanodiscus sp.	262
	4. Cryptomonas sp.	187
	5. Pennate diatoms	112
	Other genera	226
		1,910

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
04/30/74	1	0.8
	2	2.1
	3	1.1
	4	3.4
	5	3.1
	6	2.8
	7	8.1
	8	24.8
	9	8.7
	10	-

Sampling Date	Station Number	Chlorophyll a (µg/l)
07/18/74	1	1.7
	2	1.6
	3	1.5
	4	1.6
	5	1.4
	6	9.1
	7	6.2
	8	35.5
	9	14.5
	10	3.3
09/17/74	1	1.6
	2	1.6
	3	1.3
	4	1.8
	5	1.6
	6	10.8
	7	7.2
	8	30.6
	9	14.8
	10	2.7

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. Stations 1, 2, and 3 -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.005	0.110	0.1
0.050 P	0.055	0.110	1.5
0.050 P + 1.0 N	0.055	1.110	13.2
1.0 N	0.005	1.110	0.1

b. Stations 4, 5, and 6 -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.005	0.110	0.1
0.050 P	0.055	0.110	2.0
0.050 P + 1.0 N	0.055	1.110	12.0
1.0 N	0.005	1.110	0.1

c. Stations 7, 8, and 9 -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.005	0.166	0.3
0.050 P	0.055	0.166	2.0
0.050 P + 1.0 N	0.055	1.166	11.6
1.0 N	0.005	1.166	0.3

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Lake Sakakawea was low in the mid and lower portions and moderately low in the upper portion at the time the samples were collected (04/30/74). Also, the increased yields when orthophosphorus was added, and the lack of yield responses when only nitrogen was added, indicate the lake was phosphorus limited at that time.

The lake data indicate a temporal and spatial combination of limiting nutrients, although it will be noted that the stations nearest the major tributaries and point sources tended toward nitrogen limitation while the stations further away tended toward phosphorus limitation.

Following is a tabulation of the mean inorganic nitrogen/orthophosphorus ratios for each of the stations and sampling times with the indicated limiting nutrient in parentheses (the July nutrient samples from stations 6 through 10 were

not preserved properly and were not analyzed).

Station	04/30/74	07/18/74	09/17/74
1	25/1 (P)	27/1 (P)	17/1 (P)
2	28/1 (P)	21/1 (P)	42/1 (P)
3	31/1 (P)	22/1 (P)	26/1 (P)
4	34/1 (P)	22/1 (P)	16/1 (P)
5	38/1 (P)	3/1 (N)	8/1 (N)
6	28/1 (P)	-	7/1 (N)
7	27/1 (P)	-	4/1 (N)
8	10/1 (N)	-	4/1 (N)
9	28/1 (P)	-	5/1 (N)
10	not sampled	-	18/1 (P)

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the North Dakota National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for high runoff months when two samples were collected from most of the sites. Sampling was begun in September, 1974, and was completed in August, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the North Dakota District Office of the U.S. Geological Survey for selected tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads shown are those measured minus known point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads, in kg/km^2/year, at stations C-1, G-1, R-1, and S-1 and multiplying the means by the ZZ area in km^2.

The operator of the Williston wastewater treatment plant provided ten effluent samples but insufficient flow data; the operator of the Garrison plant submitted only two effluent samples; and the communities of New Town and Parshall did not participate. Nutrient loads for all

* See Working Paper No. 175.

four sources were estimated at 1.134 kg P and 3.401 kg N/capita/year.

The results of the analyses of the Williston and Garrison effluent samples are included in Appendix E for the record.

A. Waste Sources:

1. Municipal* -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Williston**	11,280	stab. ponds	4,920.5	Slough area; pumped to lake.
Garrison	1,614	stab. pond	397.4	Unnamed Stream
New Town	1,428	stab. ponds	352.0	Dry Run
Parshall	1,246	stab. ponds	306.6	E. Fk. Shell Creek

2. Industrial - Unknown

* Peterson, 1974.
** Includes slaughterhouse and meat-packing wastes.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Missouri River	1,703,180	25.4
Little Missouri River	82,675	1.2
Cherry Creek	2,925	<0.1
Yellowstone River	4,686,320	70.0
Little Muddy River	4,235	0.1
Moccasin Creek R-2	1,150	<0.1
Clarks Creek	165	<0.1
b. Minor tributaries & immediate drainage (non-point load) -	173,370	2.6
c. Municipal STP's -		
Williston	12,790	0.2
Garrison	1,830	<0.1
New Town	1,620	<0.1
Parshall	1,415	<0.1
d. Septic tanks* -	10	<0.1
e. Industrial - Unknown	?	-
f. Direct precipitation** -	26,080	0.4
Total	6,697,765	100.0

2. Outputs -

Lake outlet - Missouri River 462,250

3. Net annual P accumulation - 6,235,515 kg.

* Estimate based on 13 parks located near the lake; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/ yr	% of total
a. Tributaries (non-point load) -		
Missouri River	9,053,950	32.2
Little Missouri River	952,735	3.4
Cherry Creek	23,025	0.1
Yellowstone River	15,239,190	54.2
Little Muddy River	65,200	0.2
Moccasin Creek R-2	5,930	<0.1
Clarks Creek	1,815	<0.1
b. Minor tributaries & immediate drainage (non-point load) -	1,133,100	4.0
c. Municipal STP's -		
Williston	38,365	0.1
Garrison	5,490	<0.1
New Town	4,855	<0.1
Parshall	4,240	<0.1
d. Septic tanks* -	455	<0.1
e. Industrial - Unknown	?	-
f. Direct precipitation** -	1,608,830	5.7
Total	28,137,180	100.0

2. Outputs -

Lake outlet - Missouri River 10,446,205

3. Net annual N accumulation - 17,690,975 kg.

* Estimate based on 13 parks located near the lake; see Working Paper No. 175.
** See Working Paper No. 175.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Missouri River	7	38
Little Missouri River	4	44
Cherry Creek	4	30
Yellowstone River	26	84
Little Muddy River	2	32
Moccasin Creek R-2	20	104
Clarks Creek	2	17

E. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
Bear Den Creek	0.208	1.675
Tobacco Garden Creek	0.186	1.372
White Earth River	0.220	2.142
Little Knife River	0.241	2.130
Shell Creek	0.195	2.393
Middle Douglas Creek	0.196	2.355
Malnourie Creek	0.084	1.211
Unnamed Creek N-1	0.122	1.445
Unnamed Creek Q-1	0.450	2.882
Moccasin Creek R-1	0.147	1.414

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	4.49	4.18	18.9	11.9

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Sakakawea:

"Dangerous" (eutrophic loading)	0.68
"Permissible" (oligotrophic loading)	0.34

V. LITERATURE REVIEWED

Henegar, Dale, 1975. Personal communication (lake morphometry). ND Game & Fish Dept., Bismarck.

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Peterson, Norman L., 1974. Personal communication (municipal point sources). ND Dept. of Health, Bismarck.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
3801	LAKE ASHTABULA	27 (3)	54 (7)	15 (2)	8 (1)	62 (8)	38 (5)	204
3802	LAKE AUDUBON	69 (9)	46 (6)	46 (6)	69 (9)	46 (6)	69 (9)	345
3803	BRUSH LAKE	77 (10)	77 (10)	38 (5)	38 (5)	81 (10)	81 (10)	392
3804	LAKE DARLING	15 (2)	38 (5)	23 (3)	0 (0)	38 (5)	23 (3)	137
3805	DEVILS LAKE	0 (0)	69 (9)	31 (4)	23 (3)	15 (2)	0 (0)	138
3806	JAMESTOWN RESERVOIR	54 (7)	15 (2)	62 (8)	62 (8)	96 (12)	54 (7)	343
3807	LAKE LA MOURE	8 (1)	8 (1)	69 (9)	54 (7)	4 (0)	8 (1)	151
3808	MATEJCEK LAKE	38 (5)	0 (0)	8 (1)	100 (13)	23 (3)	31 (4)	200
3809	LAKE METIGOSHE	92 (12)	92 (12)	92 (12)	85 (11)	81 (10)	81 (10)	523
3811	PELICAN LAKE	85 (11)	100 (13)	100 (13)	77 (10)	31 (4)	100 (13)	493
3812	LAKE SAKAKAWEA (GARRISON	100 (13)	62 (8)	85 (11)	92 (12)	54 (7)	92 (12)	485
3813	SPIRIT WOOD LAKE	46 (6)	23 (3)	77 (10)	31 (4)	4 (0)	46 (6)	227
3814	SWEET BRIAR RESERVOIR	62 (8)	85 (11)	54 (7)	15 (2)	96 (12)	62 (8)	374
3815	WHITMAN LAKE	27 (3)	31 (4)	0 (0)	46 (6)	69 (9)	15 (2)	188

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
3801	LAKE ASHTABULA	0.260	0.160	472.250	40.892	10.600	0.170
3802	LAKE AUDUBON	0.087	0.220	446.222	11.322	11.000	0.015
3803	BRUSH LAKE	0.066	0.095	449.143	29.114	9.000	0.010
3804	LAKE DARLING	0.274	0.250	466.750	60.075	11.600	0.180
3805	DEVILS LAKE	0.630	0.140	449.333	38.508	14.600	0.469
3806	JAMESTOWN RESERVOIR	0.144	0.365	438.667	19.400	8.800	0.078
3807	LAKE LA MOURE	0.438	0.380	421.400	19.720	15.000	0.290
3808	MATEJCEK LAKE	0.228	0.440	475.167	2.683	14.400	0.179
3809	LAKE METIGOSHE	0.032	0.080	389.167	10.367	9.000	0.010
3811	PELICAN LAKE	0.034	0.070	364.500	10.950	12.800	0.006
3812	LAKE SAKAKAWEA (GARRISON	0.016	0.150	408.733	6.883	10.800	0.007
3813	SPIRIT WOOD LAKE	0.156	0.290	417.833	34.667	15.000	0.082
3814	SWEET BRIAR RESERVOIR	0.092	0.090	440.800	39.000	8.800	0.031
3815	WHITMAN LAKE	0.260	0.260	478.333	27.067	9.200	0.185

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	3809	LAKE METIGOSHE	523
2	3811	PELICAN LAKE	493
3	3812	LAKE SAKAKAWEA (GARRISON	485
4	3803	BRUSH LAKE	392
5	3814	SWEET BRIAR RESERVOIR	374
6	3802	LAKE AUDUBON	345
7	3806	JAMESTOWN RESERVOIR	343
8	3813	SPIRIT WOOD LAKE	227
9	3801	LAKE ASHTABULA	204
10	3808	MATEJCEK LAKE	200
11	3815	WHITMAN LAKE	188
12	3807	LAKE LA MOURE	151
13	3805	DEVILS LAKE	138
14	3804	LAKE DARLING	137

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR NORTH DAKOTA 01/08/76

LAKE CODE 3812 SAKAKAWEA RES.

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 469825.8

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
3812A1	469825.8	543.68	600.32	549.35	552.18	577.66	572.00	586.16	600.32	574.83	600.32	543.68	504.04	566.84
3812A2	238383.5	223.70	229.37	263.35	300.16	249.19	223.70	254.85	351.13	370.95	359.62	266.18	226.53	276.80
3812B1	21522.9	0.13	5.55	60.31	49.84	18.07	37.38	16.88	7.42	5.27	4.05	1.36	0.34	17.24
3812C1	761.5	0.02	0.02	0.68	2.01	0.96	0.59	0.31	0.12	0.07	0.06	0.05	0.03	0.41
3812F1	180730.1	141.58	183.21	311.49	279.49	470.06	1104.36	631.47	211.81	186.61	220.02	200.48	151.50	341.19
3812G1	2007.2	0.15	0.20	4.64	2.63	0.82	0.57	0.59	0.24	0.21	0.27	0.28	0.21	0.91
3812R2	57.0	0.00	0.0	0.05	0.16	0.07	0.03	0.03	0.01	0.01	0.01	0.01	0.00	0.03
3812S1	106.2	0.00	0.00	0.03	0.21	0.12	0.07	0.05	0.01	0.01	0.01	0.01	0.01	0.04
3812ZZ	21108.5	0.11	5.66	56.63	48.14	16.99	36.81	15.57	7.08	4.25	2.83	1.13	0.28	16.31

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 469825.8
SUM OF SUB-DRAINAGE AREAS = 464676.7

TOTAL FLOW IN = 7829.40
TOTAL FLOW OUT = 6804.53

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3812A1	9	74	656.95	21	761.72				
	10	74	804.20	19	855.17				
	11	74	688.10	15	741.90	16	671.11		
	12	74	690.93	21	688.10				
	1	75	625.80	18	549.35				
	2	75	801.37	22	812.69				
	3	75	705.09	22	736.24				
	4	75	504.04	5	509.70	18	543.68	20	441.74
	5	75	903.31	2	682.44	5	688.10	16	908.97
	6	75	1135.51	20	1056.22				
	7	75	1769.80	18	1843.43				
	8	75	1588.57	22	1274.26				
3812A2	9	74	382.28	22	382.28				
	10	74	319.98	20	322.81				
	11	74	317.15	17	305.82				
	12	74	274.67	14	288.83				
	1	75	325.64	19	501.21				
	2	75	342.63	23	385.11				
	3	75	336.97	23	336.97				
	4	75	348.30	4	263.35	5	260.51	18	311.49
	5	75	577.66	18	713.58				
	6	75	758.89	21	727.74				
	7	75	1050.55	21	1039.23				
	8	75	620.14	22	396.44				

TRIBUTARY FLOW INFORMATION FOR NORTH DAKOTA 01/08/76

LAKE CODE 3812 SAKAKAWEA RES.

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
381281	9	74	0.54	22	0.37				
	10	74	0.40	20	0.34				
	11	74	1.44	17	1.13				
	12	74	0.16	14	0.11				
	1	75	0.03	19	0.0				
	2	75	0.0	23	0.0				
	3	75	14.22	23	70.79				
	4	75	111.00	5	26.90				
	5	75	120.91	2	105.34	18	104.77		
	6	75	32.28	21	21.72	22	26.05		
	7	75	20.56	21	6.80				
	8	75	2.18	22	0.99				
3812C1	9	74	0.01	22	0.02				
	10	74	0.03	20	0.03				
	11	74	0.04	17	0.05				
	12	74	0.03	14	0.04				
	1	75	0.03	19	0.03				
	2	75	0.02	24	0.02				
	3	75	4.33	23	14.16				
	4	75	12.26	4	0.28	5	0.28		
	5	75	0.76						
	6	75	2.78	21	16.99				
	7	75	0.16	20	0.10				
	8	75	0.03	22	0.02				
3812F1	9	74	215.21	22	212.38				
	10	74	271.28	20	286.00				
	11	74	300.16	17	281.47				
	12	74	225.97	14	229.37				
	1	75	194.82	19	201.05				
	2	75	152.34	23	201.05				
	3	75	212.09	23	215.21				
	4	75	359.62	5	229.37	18	430.42		
	5	75	809.86	16	942.95				
	6	75	1282.75	21	1489.47				
	7	75	1390.36	21	1098.69				
	8	75	478.55	22	430.42				
3812G1	9	74	0.17	22	0.16				
	10	74	0.24	19	0.24				
	11	74	0.31	17	0.28				
	12	74	0.34	14	0.31				
	1	75	0.0	19	0.17				
	2	75	0.0	22	0.14				
	3	75	0.48	23	0.42				
	4	75	12.29	4	0.34	5	0.34	18	24.35
	5	75	1.76	5	2.46	16	0.76		
	6	75	0.51	22	0.40				
	7	75	0.28	21	0.28				
	8	75	0.22	22	0.21				

TRIBUTARY FLOW INFORMATION FOR NORTH DAKOTA 01/08/76

LAKE CODE 3812 SAKAKAWEA RES.

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3812R2	9	74	0.0	21	0.0				
	10	74	0.0	19	0.0				
	11	74	0.01	16	0.01				
	12	74	0.01	20	0.01				
	1	75	0.00	18	0.00				
	2	75	0.0	22	0.0				
	3	75	0.06	21	0.20				
	4	75	2.69	4	0.01	18	0.28		
	5	75	0.02	2	0.04	16	0.01		
	6	75	0.04	21	0.01				
	7	75	0.01	19	0.01				
	8	75	0.01	22	0.01				
3812S1	9	74	0.01	21	0.01				
	10	74	0.01	19	0.01				
	11	74	0.02	15	0.02	16	0.02		
	12	74	0.01	20	0.01				
	1	75	0.01	18	0.01				
	2	75	0.01	22	0.01				
	3	75	0.12	21	0.40				
	4	75	5.75	4	0.01	18	14.16		
	5	75	0.10	2	0.34	16	0.04		
	6	75	0.12	21	0.25				
	7	75	0.04	19	0.03				
	8	75	0.05	22	0.06				
3812ZZ	9	74	0.71						
	10	74	0.57						
	11	74	1.70						
	12	74	0.20						
	1	75	0.03						
	2	75	0.0						
	3	75	16.99						
	4	75	133.09						
	5	75	144.42						
	6	75	39.64						
	7	75	25.49						
	8	75	2.55						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/01/15

381201
47 30 15.0 101 26 00.0
LAKE SAKAKAWEA (GARRISON RES)
38 NORTH DAKOTA

11EPALES
3

2111202
0180 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/30	11	15 0000	3.3		234	413	8.30	150	0.040	0.200	0.150	0.010
	11	15 0005	3.2	12.6		413	8.20	159	0.040	0.200K	0.140	0.006
	11	15 0045	3.3	12.4		410	8.20	160	0.040	0.200K	0.130	0.007
	11	15 0100	3.1	12.6		410	8.20	159	0.040	0.200K	0.140	0.006
	11	15 0135	3.1	12.2		410	8.20	159	0.030	0.200K	0.130	0.005
	11	15 0170	2.5	8.0		474	7.70	178	0.030	0.200K	0.240	0.012
74/07/18	19	10 0000	24.6	8.6	144	695	8.55	177	0.040	0.900	0.090	0.006
	19	10 0005	24.6	8.4		692	8.55	174	0.020	0.300	0.080	0.005
	19	10 0015	21.5	8.4		623	8.55	173	0.020	0.200	0.080	0.004
	19	10 0020	20.9	8.4		633	8.40	175	0.030	0.200	0.100	0.004
	19	10 0060	14.9	9.2		551	8.30	171	0.040	0.200	0.100	0.004
	19	10 0110	9.7	9.8		481	8.30	172	0.040	0.200	0.130	0.006
	19	10 0176	7.4	9.2		459	8.30	176	0.040	0.200	0.140	0.007
74/09/17	13	35 0000	17.3	9.0	132	609	7.98	170	0.050	0.400	0.090	0.017
	13	35 0010	16.5	8.8		596	8.07	169	0.040	0.300	0.090	0.008
	13	35 0030	16.4	8.8		596	8.05	169	0.030	0.200	0.090	0.007
	13	35 0075	16.1	8.4		592	8.01	171	0.040	0.200K	0.090	0.005
	13	35 0125	16.0	8.6		590	7.94	169	0.040	0.200	0.090	0.005
	13	35 0150	10.6	7.4		516	7.78	171	0.040	0.300	0.180	0.013
	13	35 0170	10.3	7.6		509	7.77	171	0.040	0.200K	0.190	0.010

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/15

381201
47 30 15.0 101 26 00.0
LAKE SAKAKAWEA (GARRISON RES)
38 NORTH DAKOTA

11EPALES 2111202
3 0180 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/30	11	15 0000	0.022	0.8	
	11	15 0005	0.016		
	11	15 0045	0.016		
	11	15 0100	0.015		
	11	15 0135	0.015		
	11	15 0170	0.021		
74/07/18	19	10 0000	0.012	1.7	
	19	10 0005	0.009		
	19	10 0015	0.012		
	19	10 0020	0.010		
	19	10 0060	0.010		
	19	10 0110	0.010		
	19	10 0176	0.012		
74/09/17	13	35 0000	0.019	1.6	
	13	35 0005			50.0
	13	35 0010	0.010		
	13	35 0030	0.010		1.0
	13	35 0075	0.010		
	13	35 0125	0.009		
	13	35 0150	0.016		
	13	35 0170	0.015		

STORET RETRIEVAL DATE 76/01/15

381202
47 35 25.0 101 23 45.0
LAKE SAKAKAWEA (GARRISON RES)
38 NORTH DAKOTA

11EPALES
3

2111202
0063 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/30	11 55	0000	4.1		96	430	8.20	150	0.030	0.200K	0.100	0.005
	11 55	0005	4.1	12.4		427	8.20	150	0.030	0.200K	0.100	0.006
	11 55	0025	3.3	12.0		433	8.10	159	0.030	0.200K	0.110	0.005
	11 55	0040	2.9	11.8		436	8.10	163	0.030	0.200K	0.130	0.006
	11 55	0058	2.8	12.4		475	8.05	168	0.040	0.200K	0.150	0.005
74/07/18	19 40	0000	23.3	8.0	106	669	8.30	177	0.030	0.300	0.070	0.008
	19 40	0005	23.3	8.2		669	8.40	177	0.020	0.200	0.070	0.008
	19 40	0020	19.8	8.2		615	8.40	180	0.030	0.200	0.100	0.004
	19 40	0040	16.6	8.4		575	8.50	180	0.040	0.400	0.100	0.004
	19 40	0059	15.1	9.4		561	8.65	177	0.030	0.200	0.100	0.004
74/09/17	14 15	0000	16.0	9.0	96	587	8.03	171	0.060	0.300	0.100	0.003
	14 15	0010	15.9	9.0		586	8.04	169	0.030	0.200	0.090	0.003
	14 15	0027	15.7	8.8		585	8.04	170	0.030	0.200	0.090	0.002
	14 15	0045	15.6	8.6		584	8.04	169	0.040	0.200	0.090	0.003
	14 15	0065	14.9	9.0		579	8.04	172	0.040	0.200	0.060	0.003

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/30	11 55	0000	0.018	2.1	
	11 55	0005	0.018		
	11 55	0025	0.015		
	11 55	0040	0.009		
	11 55	0058	0.007		
74/07/18	19 40	0000	0.012	1.6	
	19 40	0005	0.010		
	19 40	0020	0.010		
	19 40	0040	0.009		
	19 40	0059	0.011		
74/09/17	14 15	0000	0.009	1.6	
	14 15	0002			50.0
	14 15	0010	0.009		
	14 15	0027	0.008		1.0
	14 15	0045	0.009		
	14 15	0065	0.015		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/15

381203
47 31 30.0 101 55 35.0
LAKE SAKAKAWEA (GARRISON RES)
38 NORTH DAKOTA

11EPALES
3

2111202
0130 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/05/01	12	50 0000	3.6		200	434	8.20	167	0.050	0.200K	0.130	0.005
	12	50 0005	3.5	12.0		434	8.15	168	0.040	0.200K	0.120	0.003
	12	50 0045	3.5	12.6		442	8.15	168	0.050	0.200K	0.130	0.005
	12	50 0080	3.2	11.6		450	8.10	178	0.040	0.200K	0.120	0.004
	12	50 0120	2.4	10.0		468	7.80	184	0.070	0.200	0.220	0.014
74/07/18	11	05 0000	22.9	8.2	168	780	7.40	168	0.060	0.300	0.120	0.005
	11	05 0005	22.7	8.2		769	7.40	169	0.040	0.200	0.100	0.004
	11	05 0030	21.2	8.4		738	7.40	169	0.060	0.200	0.120	0.009
	11	05 0060	12.8	9.6		604	7.20	169	0.060	0.200	0.140	0.008
	11	05 0090	15.9	9.4			7.40	172	0.060	0.200	0.170	0.010
	11	05 0100	14.3	9.2			7.30	181	0.060	0.200	0.170	0.018
	11	05 0126	14.2	9.4			7.00	177	0.060	0.600	0.180	0.011
74/09/16	15	30 0000	16.5	9.0	132	564	7.96	164	0.020	0.200K	0.090	0.006
	15	30 0010	16.3	8.8		563	8.00	162	0.030	0.200K	0.090	0.006
	15	30 0027	15.8	8.4		557	7.96	163	0.030	0.200K	0.090	0.006
	15	30 0055	15.8	8.8		555	7.96	153	0.030	0.200K	0.140	0.003
	15	30 0090	15.7	8.8		552	7.92	155	0.030	0.200K	0.120	0.005
	15	30 0125	10.6	7.0		514	7.67	166	0.020	0.200K	0.200	0.009

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/15

381203
47 31 30.0 101 55 35.0
LAKE SAKAKAWEA (GARRISON RES)
38 NORTH DAKOTA

11EPALES 2111202
3 0130 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/05/01	12 50	0000	0.010	1.1	
	12 50	0005	0.010		
	12 50	0045	0.012		
	12 50	0080	0.010		
	12 50	0120	0.015		
74/07/18	11 05	0000	0.011	1.5	
	11 05	0003			50.0
	11 05	0005	0.010		
	11 05	0030	0.013		1.0
	11 05	0060	0.018		
	11 05	0090	0.014		
	11 05	0100	0.018		
	11 05	0126	0.013		
74/09/16	15 30	0000	0.011	1.3	
	15 30	0010	0.013		
	15 30	0027	0.010		1.0
	15 30	0055	0.006		
	15 30	0090	0.007		
	15 30	0125	0.013		

STORET RETRIEVAL DATE 76/01/15

381204
47 37 15.0 102 20 17.0
LAKE SAKAKAWEA (GARRISON RES)
38 NORTH DAKOTA

11EPALES
3

2111202
0076 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/05/01	09 45	0000	5.3		108	425	8.10	162	0.030	0.300	0.100	0.006
	09 45	0005	5.2	11.6		423	8.10	161	0.040	0.200K	0.090	0.004
	09 45	0025	5.1	12.0		424	8.10	161	0.040	0.200K	0.080	0.005
	09 45	0050	4.9	11.6		420	8.10	162	0.040	0.200K	0.110	0.002
	09 45	0070	4.5	11.6		425	8.10	163	0.040	0.200	0.110	0.003
74/07/18	10 05	0000	29.2	8.0	166	812	7.50	158	0.060	0.300	0.120	0.018
	10 05	0005	23.9	7.8		830	7.60	164	0.040	0.200	0.120	0.008
	10 05	0015	23.6	7.8		812	7.60	161	0.060	0.200	0.120	0.006
	10 05	0030	20.8	7.0		739	7.40	157	0.070	0.200	0.130	0.008
	10 05	0050	17.3	7.4		695	7.30	164	0.080	0.200	0.160	0.008
	10 05	0065	13.6	6.4		672	7.20	176	0.090	0.300	0.200	0.011
	10 05	0081	10.6	6.2		637	7.10	171	0.120	0.300	0.220	0.013
	15 00	0000	24.8	8.0	144	734	8.60					
	15 00	0005	24.2	8.0		724	8.70					
	15 00	0023	21.4	7.6		665	8.50					
	15 00	0040	19.6	7.6		640	8.40					
	15 00	0060	12.8	7.2		659	8.30					
	15 00	0076	10.6	6.8		635	8.00					
74/09/16	14 45	0000	16.1	8.8	96	575	7.98	161	0.020	0.200K	0.100	0.007
	14 45	0010	16.0	8.6		575	7.99	164	0.020	0.200K	0.110	0.010
	14 45	0022	15.9	8.6		699	7.95	161	0.020	0.200K	0.100	0.007
	14 45	0050	15.6	7.9		682	7.95	158	0.030	0.200K	0.100	0.007
	14 45	0080	15.1	8.0		686	7.87	160	0.030	0.200K	0.110	0.008

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/15

381204
47 37 15.0 102 20 17.0
LAKE SAKAKAWEA (GARRISON RES)
38 NORTH DAKOTA

11EPALES 2111202
3 0076 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/05/01	09	45 0000	0.019	3.4	
	09	45 0005	0.016		
	09	45 0025	0.017		
	09	45 0050	0.015		
	09	45 0070	0.039		
74/07/18	10	05 0000	0.033	1.6	
	10	05 0003			50.0
	10	05 0005	0.014		
	10	05 0015	0.012		
	10	05 0022			1.0
	10	05 0030	0.016		
	10	05 0050	0.014		
	10	05 0065	0.022		
	10	05 0081	0.025		
	15	00 0000		1.2	
	15	00 0003			50.0
	15	00 0023			1.0
74/09/16	14	45 0000	0.014	1.8	
	14	45 0003			50.0
	14	45 0010	0.011		
	14	45 0022	0.012		1.0
	14	45 0050	0.012		
	14	45 0080	0.022		

STORET RETRIEVAL DATE 76/01/15

381205
47 47 12.0 102 16 51.0
LAKE SAKAKAWEA (GARRISON RES)
38 NORTH DAKOTA

KE SA

11EPALES
3

2111202
0070 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/05/01	10 20	0000	3.1		156	394	8.10	165	0.040	0.200K	0.110	0.005
	10 20	0005	3.0	12.0		393	8.10	165	0.030	0.200K	0.110	0.004
	10 20	0030	3.0	12.0		393	8.10	166	0.020	0.200K	0.130	0.003
	10 20	0065	2.3	11.2		410	8.00	175	0.040	0.200K	0.160	0.005
74/07/18	10 00	0000	24.1	7.8	216	675	8.90	167	0.050	0.600	0.110	0.051
	10 00	0005	24.0	8.2		675	8.90	165	0.040	0.200K	0.110	0.063
	10 00	0015	23.7	8.2		678	8.90	171	0.040	0.200K	0.120	
	10 00	0030	21.3	7.8		642	8.90	170	0.040	0.200K	0.120	0.088
	10 00	0050	19.8	7.6		618	8.80	161	0.060	0.200K	0.160	0.063
	10 00	0075	10.0	8.2		516	8.70	173	0.070	0.200K	0.180	0.068
	10 00	0105	8.9	7.8		508	8.60	176	0.070	0.200K	0.180	0.065
74/09/16	09 55	0000	15.5	8.8	96	477	7.93	146	0.030	0.700	0.080	0.029
	09 55	0005	15.5	8.8		476	7.91	144	0.030	0.400	0.090	0.019
	09 55	0020	15.4	9.2		476	7.92	143	0.030	0.300	0.090	0.015
	09 55	0045	14.7	8.6		468	7.93	143	0.030	0.200K	0.080	0.014
	09 55	0080	14.5	8.0		465	7.93	144	0.030	0.200	0.080	0.014
	09 55	0110	12.1	4.8		521	7.28	168	0.080	0.200K	0.200	0.018

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/15

381205
47 47 12.0 102 16 51.0
LAKE SAKAKAWEA (GARRISON RES)
38 NORTH DAKOTA

KE SA

11EPALES 2111202
3 0070 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/05/01	10	20 0000	0.017	3.1	
	10	20 0005	0.016		
	10	20 0030	0.016		
	10	20 0065	0.015		
74/07/18	10	00 0000	0.063	1.4	
	10	00 0003			50.0
	10	00 0005	0.080		
	10	00 0015	0.079		
	10	00 0030	0.117		1.0
	10	00 0050	0.065		
	10	00 0075	0.075		
	10	00 0105	0.079		
74/09/16	09	55 0000	0.032	1.6	
	09	55 0003			50.0
	09	55 0005	0.034		
	09	55 0020	0.020		1.0
	09	55 0045	0.014		
	09	55 0080	0.022		
	09	55 0110	0.051		

STORET RETRIEVAL DATE 76/01/15

381206
47 58 49.0 102 33 27.0
LAKE SAKAKAWEA (GARRISON RES)
38 NORTH DAKOTA

11EPALES 2111202
3 0072 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/05/01	10 50	0000	3.4		84	423	8.10	165	0.050	0.200	0.140	0.006
	10 50	0005	3.3	11.6		422	8.10	165	0.060	0.200K	0.130	0.007
	10 50	0025	3.3	11.6		435	8.05	166	0.030	0.200K	0.100	0.005
	10 50	0065	3.3	9.6		434	8.10	166	0.050	0.200K	0.140	0.007
74/07/18	10 45	0000	24.2	8.4	36	457	8.90					
	10 45	0005	23.7	8.4		453	8.80					
	10 45	0015	23.1	8.2		452	8.70					
	10 45	0030	21.6	7.6		433	8.40					
	10 45	0045	21.0	7.6		468	8.40					
	10 45	0060	13.3	6.2		518	8.30					
	10 45	0075	12.5	6.4		522	8.20					
74/09/16	10 45	0000	14.9	9.6	48	426	7.87	136	0.030	0.200	0.090	0.018
	10 45	0005	14.9	8.8		426	7.88	138	0.030	0.200K	0.100	0.020
	10 45	0015	14.8	8.4		426	7.85	136	0.030	0.200K	0.100	0.019
	10 45	0040	14.7	8.6		425	7.86	139	0.030	0.200K	0.100	0.018
	10 45	0073	14.6	9.8		428	7.86	137	0.030	0.200K	0.100	0.018

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/05/01	10 50	0000	0.027	2.8	
	10 50	0005	0.026		
	10 50	0025	0.027		
	10 50	0065	0.028		
74/07/18	10 45	0000		9.1	
	10 45	0010			1.0
74/09/16	10 45	0000	0.034	10.8	
	10 45	0005	0.023		
	10 45	0013			1.0
	10 45	0015	0.024		
	10 45	0040	0.022		
	10 45	0073	0.023		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/15

381207
48 07 33.0 103 13 15.0
LAKE SAKAKAWEA (GARRISON RES)
38 NORTH DAKOTA

11EPALES
3

2111202
0025 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/30	14 55	0000	11.3		24	548	8.20	164	0.040	0.300	0.220	0.006
	14 55	0005	11.3	12.0		549	8.20	167	0.050	0.200	0.240	0.011
	14 55	0015	10.0	9.8		527	8.20	170	0.040	0.300	0.220	0.011
	14 55	0021	6.7	11.2		418	8.30	145	0.040	0.300	0.090	0.007
74/07/18	11 30	0000	24.3	8.4	24	449	8.50					
	11 30	0005	24.1	4.2		443	8.40					
	11 30	0015	23.5	7.8		434	8.30					
	11 30	0030	23.2	7.0		448	8.00					
74/09/16	11 30	0000	13.6	9.4	48	478	8.04	161	0.040	0.200K	0.020	0.015
	11 30	0005	13.6	9.8		477	8.06	163	0.030	0.200K	0.020K	0.015
	11 30	0015	13.2	9.6		474	8.02	164	0.030	0.200K	0.020K	0.015
	11 30	0031	13.1	9.0		473	8.02	163	0.030	0.200K	0.020K	0.013

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/30	14 55	0000	0.051	8.1	
	14 55	0005	0.051		
	14 55	0015	0.065		
	14 55	0021	0.044		
74/07/18	11 30	0000		6.2	
	11 30	0005			1.0
74/09/16	11 30	0000	0.018	7.2	
	11 30	0005	0.020		
	11 30	0014			1.0
	11 30	0015	0.020		
	11 30	0031	0.027		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/15

381208
48 08 32.0 103 35 48.0
LAKE SAKAKAWEA (GARRISON RES)
38 NORTH DAKOTA

11EPALES
3

2111202
0010 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/30	15 30	0000	10.9		12	715	8.30	314	0.050	1.000	0.080	0.014
	15 30	0002	10.9	8.8		715						
	15 30	0007	10.5	8.4		714	8.30	324	0.060	1.100	0.110	0.016
74/07/18	12 15	0000	24.0	6.6	10	616	8.60					
	12 15	0004	23.9	6.8		591	8.50					
	12 15	0009	23.9	6.2		630	8.50					
74/09/16	12 25	0000	13.7	9.4	18	578	8.20	186	0.030	0.200K	0.020K	0.011
	12 25	0005	13.1	8.6		644	8.19	250	0.030	0.400	0.020K	0.014

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/30	15 30	0000	0.153	24.8	
	15 30	0007	0.163		
74/07/18	12 15	0000		35.5	
	12 15	0001			1.0
74/09/16	12 25	0000	0.050	30.6	
	12 25	0005	0.072		1.0

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/15

381209
48 06 45.0 103 42 00.0
LAKE SAKAKAWEA (GARRISON RES)
38 NORTH DAKOTA

11EPALES 2111202
3 0005 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/30	15 50	0000	12.1	9.6	6	689	8.10	176	0.090	1.000	0.470	0.020
74/07/18	12 00	0000	23.7	7.0	6	495	8.20					
74/09/16	12 10	0000	14.5	9.2	12	504	8.06	169	0.030	0.200	0.020K	0.011

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/30	15 50	0000	0.705	8.7	
74/07/18	12 00	0000		14.5	
74/09/16	12 10	0000	0.068	14.8	
	12 10	0003			1.0

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/15

381210
47 37 18.0 102 36 12.0
LAKE SAKAKAWEA
38 NORTH DAKOTA

11EPALES
3

2111202
0012 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/07/18	14 25	0000	26.5	7.4	72	1289	8.50					
	14 25	0004	25.7	7.2		1291	8.50					
	14 25	0008	24.6	6.6		1435	8.60					
74/09/16	14 20	0000	14.9	9.0	48	1007	8.19	238	0.030	0.300	0.140	0.010
	14 20	0006	14.5	9.0		1012	8.21	236	0.030	0.200	0.150	0.010

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/07/18	14 25	0000		3.3	
	14 25	0010			1.0
74/09/16	14 20	0000	0.022	2.7	
	14 20	0006	0.030		

APPENDIX E

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/02/02

3812A1
47 30 08.0 101 25 50.0
MISSOURI RIVER
38 7.5 GARRISON D N
O/SAKAKAWEA LAKE
BNK SAM AT CENTER OF CHANNEL OFF HWY 200
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/09/21	13 05		0.096	0.200	0.010	0.005K	0.010		
74/10/19	11 40		0.144	0.400	0.015	0.005	0.010		
74/11/16	10 35		0.096	0.300	0.020	0.005K	0.010K		
74/12/21	10 30		0.104	0.200	0.016	0.005K	0.010K		
75/01/18	11 00		0.116	0.300	0.024	0.007	0.050		
75/02/22	10 30		0.128	0.350	0.049	0.008K	0.010K		
75/03/22	14 00		0.110	0.300	0.020	0.005	0.010K		
75/04/05	12 05		0.105	0.200	0.040	0.005	0.010K		
75/04/18	13 30		0.085	0.050K	0.035	0.005	0.010		
75/04/20	08 30		0.945	2.500	0.280	0.190	0.310		
75/05/02	13 18		0.085	0.650	0.055	0.005	0.020		
75/05/05	09 00		0.090	0.250	0.015	0.005	0.010K		
75/05/16	13 25		0.120	1.230	0.015	0.020			
75/06/20	12 45		0.090	0.150	0.025	0.005K	0.030		
75/07/18	13 10			0.200			0.010K		
75/08/22	13 45		0.185	0.400	0.005	0.010	0.050		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/13

3812A2
48 00 00.0 104 05 40.0
MISSOURI RIVER
38 7.5 BAINVILLE SE
T/SAKAKAWEA LAKE
MT HWY 58 BRDG 2 MI S OF SNOWDEN MT
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/22	11 19		0.028	0.300	0.005	0.015	0.086
74/10/20	08 30		0.008	1.100	0.020	0.015	0.080
74/11/17	08 15		0.008	0.700	0.020	0.015	0.050
74/12/14	11 30		0.012	1.000	0.015	0.010	0.060
75/04/04	10 38		0.185	1.000	0.025	0.020	0.400
75/05/18	11 00		0.130	1.400	0.010	0.020	0.560
75/06/21	13 00		0.020	1.800	0.015	0.010	0.200
75/07/21	07 15			0.500			0.210
75/08/22	18 00		0.085	0.600	0.015	0.020	0.160

STORET RETRIEVAL DATE 76/01/13

381281
47 35 25.0 103 15 05.0
LITTLE MISSOURI RIVER
38 MCKENZIE CO HWY
T/SAKAKAWEA LAKE
US HWY 85 BRDG 17.5 MI S OF WATFORD CITY
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/22	16	42	0.004	0.600	0.005K	0.005	0.045
74/10/20	11	35	0.008	1.800	0.030	0.005	0.040
74/11/17	10	10	0.504	1.600	0.045	0.015	0.500
75/05/02	11	00	0.525		0.063	0.045	
75/05/18	09	00	0.270	3.500	0.025	0.045	0.260
75/06/21	09	45	0.025	1.250	0.025	0.010	0.150
75/06/22	13	00	0.090	1.050	0.200	0.005	0.070
75/07/21	01	00		0.550			0.260
75/08/22	19	00	0.015	0.400	0.035	0.010	0.090

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/13

3812C1
47 44 30.0 103 07 50.0
CHERRY CREEK
38 MCKENZIE CO HWY
T/SAKAKAWEA LAKE
SEC RD BRDG 8 MI SE OF WATFORD CITY
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/22	14 29		0.008	1.800	0.005K	0.035	0.155
74/10/20	12 45		0.032	1.200	0.020	0.040	0.140
75/06/21	15 00		0.005	1.550	0.045	0.050	0.225
75/07/20	09 15			1.900			0.540
75/08/22	20 00		0.005	1.750	0.020	0.060	0.210

K VALUE KNOWN TO BE
LESS THAN INDICATED

84

STORET RETRIEVAL DATE 76/02/02

3812D1
47 48 45.0 102 43 00.0
BEAR DEN CREEK
38 7.5 SANISH SW
T/SAKAKAWEA LAKE
ND HWY 22 BRDG 7.7 MI NNW OF MANDAREE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/09/21	11 30		0.011	0.800	0.005K	0.020	0.040		
74/10/19	12 50		0.024	1.500	0.030	0.005	0.030		
74/11/16	13 36		0.008	0.500	0.040	0.005	0.060		
75/03/21	12 35		0.315	2.600	0.290	0.195	0.500		
75/04/04	13 50		0.185	1.450	0.270	0.085	0.150		
75/04/18	12 55		0.460	1.450	0.280	0.050	0.960		
75/05/02	12 15		0.840	2.100	0.110	0.050	0.310		
75/05/16	12 30		0.005	0.950	0.015	0.010	0.040		
75/06/21	10 35		0.010	1.750	0.032	0.010	0.140		
75/07/19	12 15			1.080	0.015	0.010	0.070		
75/08/22	12 30		0.240	1.550	0.045	0.035	0.190		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/13

3812E1
48 44 00.0 103 07 15.0
TOBACCO GARDEN CREEK
38 MCKENZIE CO HWY
T/SAKAKAWEA LAKE
SEC RD BRDG 1.5 MI S OF MOUTH OF CREEK
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/22	15	31	0.020	1.400	0.005K	0.020	0.100
74/10/20	13	35	0.016	1.400	0.030	0.007	0.070
74/11/17	11	20	0.008	1.000	0.025	0.010	0.070
75/05/05	09	30	0.330	1.550	0.040	0.025	0.460
75/06/21	16	30	0.005	1.650	0.040	0.065	0.170
75/07/20	10	30		3.150	1.250		0.350
75/08/22	21	30	0.005	0.850	0.015	0.010	0.080

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/13

3812F1
47 51 45.0 103 58 00.0
YELLOWSTONE RIVER
38 MCKENZIE CO HWY
T/SAKAKAWEA LAKE
ND HWY 200 BRDG 2 MI E OF CARTWRIGHT
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/22	12	11	0.012	1.100	0.005	0.005	0.050
74/10/20	09	15	0.048	0.900	0.010	0.005K	0.050
74/11/17	09	00	0.256	0.400	0.035	0.010	0.050
75/04/18	10	15	0.390	1.850	0.070	0.025	0.800
75/05/16	10	30	0.510	1.800	0.015	0.025	0.880
75/06/21	13	43	0.230	2.100	0.025	0.015	1.200
75/07/21	18	30		1.330	0.045		0.940
75/08/22	20	30	0.005	0.500	0.005	0.010	0.090

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/13

3812G1
48 17 04.0 103 34 21.0
LITTLE MUDDY RIVER
38 7.5 MARMON SE
T/SAKAKAWEA LAKE
SEC RD BRDG 10 MI NNE OF WILLISTON
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/22	09	34	0.008	1.100	0.025	0.020	0.080
74/10/19	14	30	0.024	1.250	0.040	0.005	0.055
74/11/17	13	00	0.008	0.600	0.030	0.010	0.030
74/12/14	09	15	0.032	2.900	0.150	0.005	0.020
75/02/22	13	05	0.040	1.600	0.240	0.008	0.010K
75/04/04	11	30	0.860	3.000	0.155	0.070	0.480
75/05/05	13	30	0.100	1.700	0.090	0.052	0.180
75/05/16	12	00	0.005	1.000	0.015	0.025	0.145
75/06/22	15	00	0.010	4.200	0.060	0.070	0.420
75/07/21	13	00		2.800			
75/08/22	23	30	0.210	2.100	0.075	0.045	0.130

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/13

3812H1
48 46 45.0 102 12 45.0
WHITE EARTH RIVER
38 MOUNTRAIL CO HWY
T/SAKAKAWEA LAKE
SEC RD 1804 BRDG 12 MI S OF WHITE EARTH
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/22	13 15		0.007	2.900	0.005K	0.050	0.230
74/10/21	14 00		0.024	1.600	0.025	0.020	0.090
74/11/18	15 00		0.008	1.800	0.025	0.050	0.115
74/12/19	13 45		0.008	2.100	0.010	0.030	0.130
75/01/17	14 30		0.032	1.350	0.124	0.045	0.130
75/02/20	12 50		0.082	2.100	0.096	0.048	0.080
75/03/18	13 25		0.560	2.500	0.200	0.280	0.500
75/04/18	12 55		0.850	2.400	0.195	0.090	0.420
75/05/06	18 15		0.080	1.900	0.040	0.120	0.340
75/05/17	12 15		0.020	1.650	0.040	0.105	0.240
75/06/23	14 00		0.030	1.700	0.030	0.085	0.190
75/07/22	11 20			1.500			
75/08/20	13 05		0.005	2.000	0.020	0.025	0.180

K VALUE KNOWN TO BE
LESS THAN INDICATED

FIRST ARRIVAL DATE 74/01/13

381201
48 32 30.0 102 04 45.0
LITTLE KNIFE RIVER
38 MOUNTRAIL CO HWY
T/SAKAKAWEA LAKE
SEC RD BRDG 10 MI NNW OF NEWTOWN
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/22	12 45		0.008	1.300	0.005K	0.055	0.135
74/10/21	13 25		0.008	1.200	0.030	0.035	0.100
74/11/18	14 30		0.008	1.500	0.040	0.065	0.100
74/12/14	13 15		0.016	2.000	0.035	0.045	0.220
75/02/20	12 00		0.032	4.800	0.272	0.208	0.220
75/03/18	13 00		0.260	2.700	0.630	0.300	0.500
75/04/18	12 30		0.650	2.350	0.390	0.170	0.345
75/05/04	17 45		0.220	2.300	0.155	0.090	0.280
75/05/17	11 45		0.010	2.200	0.195	0.150	0.230
75/06/23	13 30		0.025	2.400	0.045	0.300	0.400
75/07/22	11 00			1.550			0.320
75/08/20	12 30		0.305	1.000	0.015	0.100	0.190
75/09/22	12 30		0.010	0.750	0.010	0.040	0.090

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STORET RETRIEVAL DATE 76/01/13

3812K1
48 03 11.0 102 08 10.0
SHELL CREEK
38 MOUNTRAIL CO HWY
T/SAKAKAWEA LAKE
SEC RD 192 BRDG 6 MI NNW OF PARSHALL
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/21	11 10		0.004	2.200	0.005K	0.020	0.070
74/10/21	12 35		0.008	1.000	0.025	0.010	0.040
74/11/18	12 30		0.008	2.200	0.035	0.020	0.080
74/12/19	11 45		0.008	1.900	0.195	0.025	0.070
75/01/17	11 45		0.008	2.600	0.552	0.045	0.085
75/02/20	10 15		0.005K	4.200	1.061	0.022	0.120
75/03/18	11 25		0.740	3.450	0.430	0.560	0.750
75/04/18	11 10		1.250	2.200	0.400	0.155	0.230
75/05/06	16 25		0.010	1.800	0.030	0.050	0.160
75/05/17	10 50		0.010	2.000	0.045	0.095	0.190
75/06/23	12 25		0.010	2.500	0.040	0.175	0.250
75/07/22	10 05			1.500			0.290
75/08/20	11 45		0.005	1.600	0.030	0.130	0.200

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/13

3812L1
47 38 55.0 101 32 50.0
MID BRANCH DOUGLAS CRK
38 7.5 EMMET NE
T/SAKAKAWEA LAKE
ND HWY 37 BRDG 6.2 MI W OF GARRISON
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/21	10 00		0.012	1.900	0.005K	0.055	0.140
74/10/21	11 30		0.008	1.700	0.030	0.010	0.100
74/11/18	11 30		0.008	1.800	0.075	0.025	0.070
74/12/19	10 35		0.056	1.950	0.330	0.030	0.100
75/01/17	10 25		0.008	2.800	0.480	0.050	0.090
75/02/19	10 00		0.008	4.000	0.552	0.096	0.270
75/03/18	09 45		0.490	3.150	0.530	0.230	0.420
75/04/18	09 55		1.000	1.800	0.140	0.130	0.260
75/05/06	15 10		0.040	1.650	0.055	0.085	0.180
75/05/17	09 30		0.010	2.100	0.052	0.105	0.220
75/06/23	11 15		0.010	2.400	0.045	0.135	0.230
75/07/22	09 10			1.900			0.350
75/08/20	10 40		0.005	1.350	0.020	0.055	0.120

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/13

3812M1
47 30 55.0 102 08 20.0
MALNOURIE CREEK
38 7.5 TWIN BUTTES
T/SAKAKAWEA LAKE
SEC RD BRDG 5.8 MI E OF TWIN BUTTES
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/03/22	11 20		0.135	2.000	0.250	0.085	0.250
75/04/18	11 40		0.315	1.450	0.210	0.035	0.120
75/05/02	11 42		0.250	0.500	0.115	0.020	0.110
75/05/16	11 47		0.005	1.200	0.015	0.010	0.030
75/06/20	11 10		0.005	0.950	0.025	0.010	0.010
75/07/18	11 40			0.550			0.020
75/08/22	11 40		0.005	0.450	0.015	0.010	0.050

STORET RETRIEVAL DATE 76/01/13

3812N1
47 30 05.0 102 09 05.0
UNNAMED CREEK
38 7.5 TWIN BUTTES
T/SAKAKAWEA LAKE
BANK SAMP 1.4 MI SSW OF SITE 3812MI
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/03/22	11	10	0.080	1.650	0.070	0.090	0.270
75/05/02	11	32	0.250	1.350	0.173	0.020	0.160
75/05/16	11	35	0.005	1.000	0.020	0.010	0.040
75/07/18	11	25		0.600			0.020

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STORET RETRIEVAL DATE 76/01/13

381201
47 36 55.0 102 50 15.0
UNNAMED CREEK
38 7.5 LOST BRIDGE
T/SAKAKAWEA LAKE
ND HWY 20 BRDG 1.2 MI N OF LOST BRIDGE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/03/21	10 45		0.150	3.750	0.042	0.087	0.980
75/04/18	10 30		0.315	2.700	0.075	0.030	0.310
75/05/02	14 35		0.820	2.100	0.100	0.010	0.540
75/05/16	10 30		0.410	1.750	0.075	0.005	0.060
75/06/20	08 45		0.315	2.100	0.040	0.005	0.360

STORET RETRIEVAL DATE 76/01/13

3812R1
47 35 50.0 102 30 40.0
MOCCASIN CREEK
38 7.5 MANDAREE SE
T/SAKAKAWEA LAKE
SEC RD BRDG UPSTRM FROM LAKE SAKAKAWEA
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/03/21	11 45		0.085	1.650	0.035	0.080	0.340
75/04/04	08 54		0.560		0.095	0.020	
75/04/18	11 45		0.220	1.800	0.065	0.040	
75/05/02	10 40		0.120	0.750	0.035	0.015	0.190
75/05/16	11 25		0.010	1.480	0.020	0.005	0.065
75/07/19	10 50			1.050			0.070
75/08/22	11 15		0.005	0.950	0.010	0.010	0.070

STORET RETRIEVAL DATE 76/01/13

381282
47 37 00.0 102 36 15.0
MOCCASIN CREEK
38 7.5 MANDAREE SE
T/SAKAKAWEA LAKE
SEC RD BRDG 6.5 M ESE OF JCT WITH HWY 22
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/11/16	11 45		0.008	0.500	0.020	0.005	0.030
75/03/21	11 15		0.060	1.700	0.030	0.065	0.280
75/04/18	11 10		0.210	1.250	0.040	0.020	0.150
75/05/02	10 15		0.075	0.600	0.025	0.015	0.140
75/05/16	11 00		0.005	0.900	0.015	0.005	0.040
75/06/21	09 15		0.015	0.950	0.020	0.010	0.080
75/07/19	10 20			1.200			0.050
75/08/22	10 45		0.005	0.700	0.005K	0.010	0.040

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/01/13

3812S1
47 55 30.0 102 44 25.0
CLARKS CREEK
38 7.5 SANISH NW
T/SAKAKAWEA LAKE
HWY 22 BRDG 3.7 M S OF JCT WITH HWY 23
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/21	13 55		0.010	1.000	0.025	0.030	0.080
74/10/19	13 15		0.016	0.500	0.010	0.025	0.060
74/11/16	13 14		0.008	0.700	0.020	0.045	0.100
75/03/21	13 00		0.350	2.100	0.115	0.007	0.010
75/04/04	13 10		0.005	0.900	0.095	0.105	0.140
75/04/18	13 15		0.480	1.750	0.130	0.040	0.420
75/05/02	11 35		0.560	1.300	0.085	0.025	0.140
75/05/16	12 50		0.005	1.550	0.025	0.010	0.050
75/06/21	11 00		0.012	1.480	0.010	0.010	0.085
75/07/19	12 05			2.000			0.100

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STORET RETRIEVAL DATE 76/01/16

3812WA PD3812WA P011280*
48 08 20.0 103 36 40.0
WILLISTON
38 7.5 WILLISTON W.
T/SAKAKAWEA LAKE
SLOUGH TO LAKE SAKAKAWEA
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/12/23	12 00		0.160	35.000	16.500	8.250	13.000	1.200	1.200
75/01/27			0.072	51.000	37.550	12.000	12.500		
75/02/27	11 30			11.000			16.000		
75/03/25	16 00		0.080	18.000	7.100	4.900	5.400		
75/04/30	16 00		0.150	26.500	10.000	6.000	7.300		
75/06/13	08 00		0.100	35.000	14.000	7.780	10.000		
75/06/30	08 00		0.225	30.000	7.900	4.900	9.900		
75/10/09	08 00		2.100	12.500	0.080	6.500	9.750		
75/10/14	16 00		1.300	15.000	0.360	6.200	9.400		
75/10/21	16 30		0.675	16.000	0.175	7.200	9.300		

STORET RETRIEVAL DATE 76/01/16

3812XA PD3812XA P001614
47 38 50.0 101 25 45.0
GARRISON
38 15 GARRISON
T/SAKAKAWEA LAKE UN
NAMED STREAM TO LAKE SAKA KAWEA
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/12/09			0.080	21.000	4.800	6.000	10.500	0.148	0.125
75/10/28	08 00		0.275	17.000	0.170	5.900	7.900		